
Space Weather Technical Forecast

Issued on Tuesday, 21 November 2023 at 13:08 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Increasing Chance of R1. Risk of G1, peaking day 1 (21 Nov), due to coronal hole high speed stream influences.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was low, with several C-class flares. There are currently eleven sunspot groups on the disc, with the majority of which located in the eastern solar hemisphere, and two of which are unnumbered. AR3489 (Dai/Beta-Delta) maintains its magnetic complexity, with a delta spot present within its intermediate portion. The large number of regions in the northeast make analysis very challenging with AR3492 the largest and most complex, though most regions appear to be small, simple and stable at present. Numerous filament and prominence eruptions were apparent on coronagraph imagery in the period, although the vast majority appear to be far-sided or else emanated from the limbs. No Earth-directed CMEs observed in the past 24 hours.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE and DSCOVR at L1, have been in a slow-ambient regime, but have slowly increased from 310km/s to 380km/s. This may be associated with a weak connection to coronal hole 73. The solar density, however, has fluctuated significantly, regularly above average, peaking 29 ppcc at 20/2224 UTC. The IMF was predominantly weak, though became moderate for periods after 21/0200 UTC, peaking at moderate levels, 13nT at 21/0628 UTC. The all-important north-south component (Bz) became moderate for a while with a significant negative period between 21/0600-0800UTC, falling to -13nT. Finally, the phi angle was mainly negative (towards the Sun), but re-orientated to positive (away from the Sun) from 20/1800UTC. The net result of the above solar wind parameters was for Quiet geomagnetic activity until 21/0600 UTC, after which it became Active (Kp4).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux remained at Background levels.

GOES16 high energy (greater than 2MeV) electron flux ranged from Normal Background to Moderate levels, with a peak of 449pfu at 20/1610UTC. The associated 24-hour fluence has remained below the Active threshold (1e8 integrated pfu). The fluence observation at 21/0001UTC was 7.18e6 integrated pfu.

Four-Day Space Weather Forecast Summary

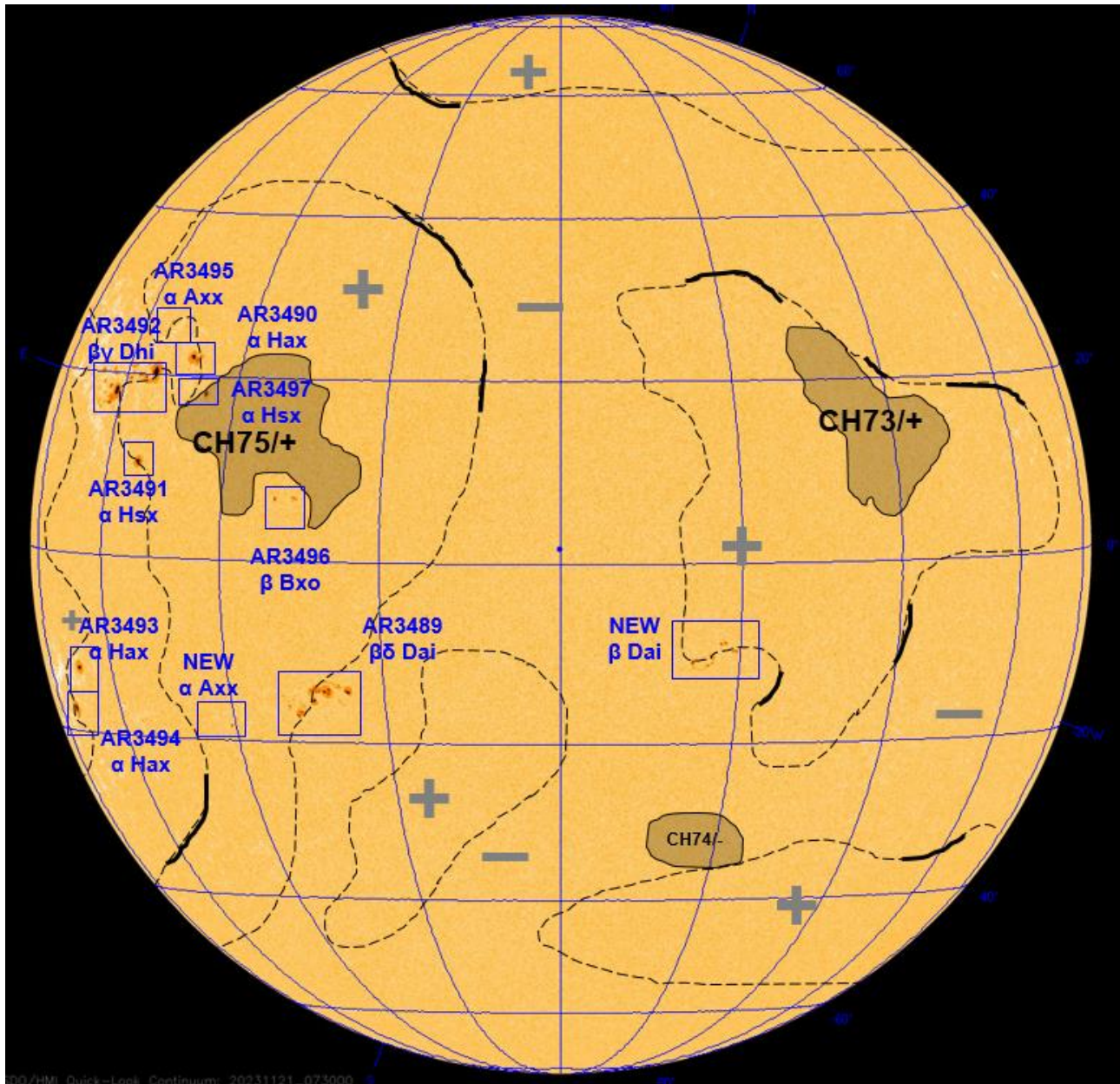
Solar Activity: There is a daily Chance of M-class flares, mainly from current eastern solar horizon sunspot regions, perhaps rising slightly as a result of increased complexity as a cluster of sunspots in the northeast rotates westwards across the disk.

Solar Wind / Geomagnetic Activity: Solar winds are currently at background levels, although may increase to slightly elevated or elevated levels, between 450-500km/s later on Day 1 (21 Nov), possibly lasting into Day 2 (22 Nov) before waning and declining to background levels by Days 3 and 4 (23-24 Nov). Geomagnetic activity is currently Active, with a Slight Chance of a G1/Minor Storm on Day 1 (21 Nov), possibly into Day 2 (22 Nov), becoming mostly Quiet by Day 3 (23 Nov).

Energetic Particles / Solar Radiation: GOES16 high energy proton flux is expected to remain at Background levels.

GOES16 high energy electron flux is expected to continue to peak at Moderate levels, before perhaps a steady rise by the end of the period. The associated 24-hour electron fluence will most likely remain below the Active ($1e8$ integrated pfu) level in this four-day period, but with a probable increasing trend into towards the end of the period.

Figure 1. Solar Analysis Valid 21/0800 UTC.



Key: Filament —, Prominence —, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - $\beta\gamma$ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

No Earth-directed CMEs currently feature in the forecast.

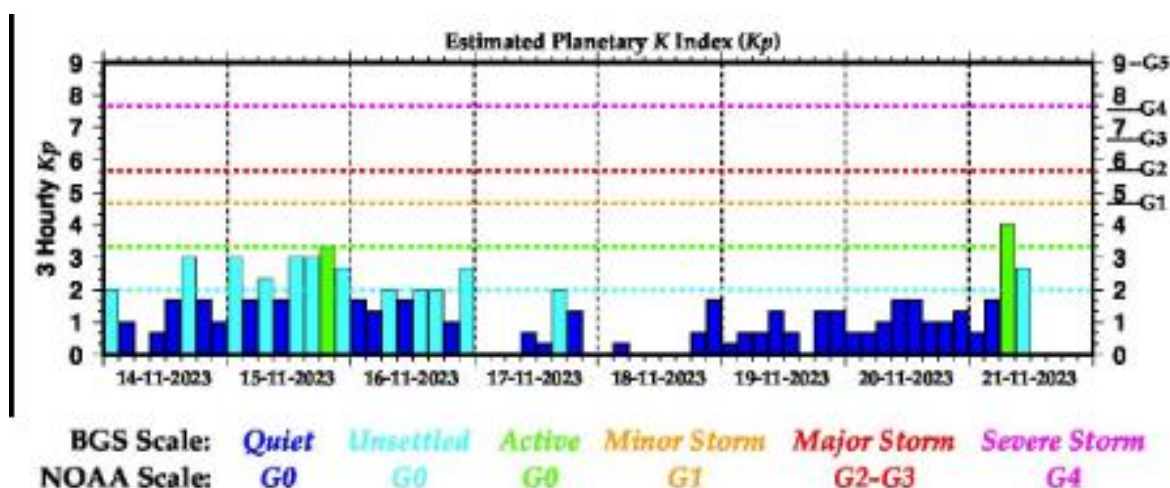
The coronal hole-based forecast now comprises of a likely connection to CH73/+, this is weak at the moment but may strengthen before the end of day 1 (21 Nov) resulting in elevated wind speeds above 500 km/s. During Day 2 (22 Nov) winds are likely to return to background levels. In terms of other potential sources of geomagnetic activity in the forecast that are not yet quantified in the percentages, much of the CME activity seen on available coronagraph imagery over the past 24 hours has been tied to the eastern solar horizon. This is likely to play an increasing role in the risk of geomagnetic activity through the period should activity persist. In addition to this, there are a number of filaments on the disc which have the potential to disrupt and lift-off, perhaps producing Earth-directed CMEs, although there is nothing to imply this is imminent or in progress at the time of writing.

Overall, the geomagnetic forecast is Unsettled to Active with a Slight Chance of a G1/Minor Storm during Day 1 (21 Nov). Possibly lingering into Day 2 (22 Nov). Reducing to mostly Quiet or Unsettled by Days 3 and 4 (23-24 Nov).

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	20	10	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections- Nil

Figure 2: Estimated Planetary K index (Kp) from BGS

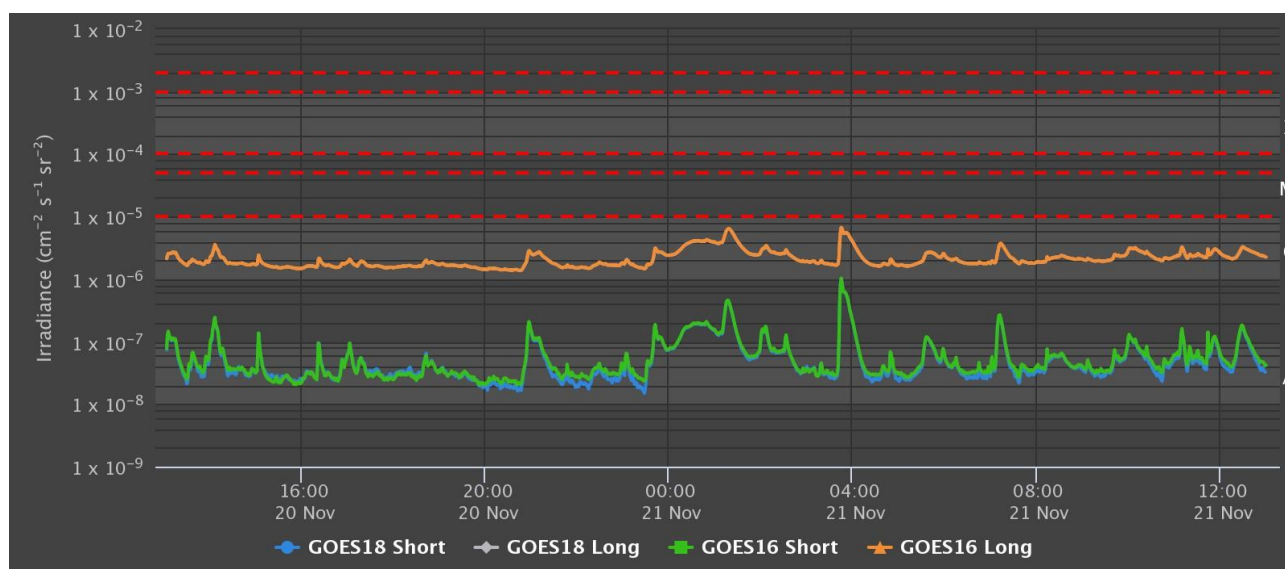


Radio Blackouts - X-Ray Flares:

There are currently eleven sunspot groups on the disc, with the majority of which are located in the eastern solar hemisphere, and two of which are unnumbered. AR3489 (Dai/Beta-Delta) maintains its magnetic complexity, with a delta spot present within its intermediate portion. The large number of regions in the northeast make analysis very challenging with AR3492 the largest and most complex, though most regions appear to be small, simple and stable at present. All considered, there is a rising Chance of M-class flares given the complex eastern solar horizon and the potential for more regions arriving here. X-class flares are now also considered a daily Slight Chance given the potential for development in the eastern hemisphere.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	50	50	50
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3:GOES16 X-Ray flux



Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is currently at Background levels.

The arrival of one of potentially several large and complex regions over the eastern solar horizon over the coming days has resulted in an above background risk of a S1/Minor Solar Radiation Storm. This risk remains nominal until any significant groups approach the western solar hemisphere.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	5	5	5	5
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm⁻²sr⁻¹s⁻¹)

High Energy Electrons Event (≥ 2MeV):

Electron flux levels are expected to continue fluctuating between Normal Background and Moderate flux levels. Later in the period flux levels may increase with a chance of the High 1000 pfu threshold being breached near the diurnal maximum.

Fluence levels are expected to remain below the 1e8 Active threshold, though the risk of this being breached does increase later in the period.

GEO Electron Environment	Level (cm ⁻² sr ⁻¹ day ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1x10 ⁸	No	1	1	10	20
Very Active	≥ 2 MeV ≥ 1x10 ⁹	No	1	1	1	1

Figure 4: MOSWOC REF Model

